DOCUMENT RESUME

ED 399 877 HE 029 512

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TITLE Graduate Women in Engineering.
INSTITUTION Maryland Univ., College Park. Counseling Center.
SPONS AGENCY Alfred P. Sloan Foundation, New York, N.Y.; Maryland Univ., College Park. A. James Clark School of Engineering.
REPORT NO UMCP-RR-18-95
PUB DATE 95
NOTE 17p.
PUB TYPE Reports - Descriptive (141) -- Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Academic Persistence; Dropout Prevention; *Educational Innovation; Educational Objectives; *Engineering Education; Focus Groups; Graduate Students; *Graduate Study; Higher Education; Mentors; Social Support Groups; *Womens Education
IDENTIFIERS *University of Maryland College Park

ABSTRACT

The transition from undergraduate to graduate school is a point when female students may lose interest in pursuing engineering degrees, and the percentage of women enrolled in engineering graduate programs is small in comparison to that of males. To attempt to mitigate the potential isolation of women graduate engineering students, the Women in Engineering Program at the University of Maryland, College Park, has established a Graduate Committee for Women Engineers to mentor and assist women graduate students in their professional development. To learn how best to facilitate and support this group, a survey was distributed to all women enrolled in engineering graduate studies during the spring semester 1995 and a 90-minute focus group was conducted 2 weeks after the survey data were analyzed. Respondents to the survey were interested in attending workshops on career issues, receiving support from female faculty and other graduate women students, and developing networks. The focus group discussions identified incoming first-year Master's and doctoral students and international students as groups needing special attention. (MAH)

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Research Report #18-95

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This program was funded by the A. James Clark School of Engineering,
the University of Maryland, College Park and the Alfred P. Sloan Foundation

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Summary

There are several points along the science pipeline that female students lose interest in pursuing engineering degrees. The transition from undergraduate to graduate school is considered one of the most severe (Widnall, 1988). As a result, there is a low percentage of women enrolled in graduate engineering across the nation; in 1994, women made up 16.9% of the students enrolled in master's programs and 14.8% of the students enrolled in doctoral programs (Engineering Workforce Commission, 1994). Similar to this national enrollment trend, the percentage of women enrolled in engineering graduate degree programs at the A. James Clark School of Engineering at the University of Maryland at College Park (UMCP) remains small in comparison to that of males. Without a community of female peers, women engineering students are at risk for experiencing feelings of isolation and ultimately, may be at risk for departing from the engineering pipeline (Miller, 1993).

In order to mitigate the potential isolation experienced by women in graduate engineering education, the Women in Engineering Program at UMCP used funding from the Alfred P. Sloan Foundation to establish a Graduate Committee for Women Engineers. The purpose of the Graduate Committee for Women Engineers was to build a cohesive group of women graduate students to mentor and assist each other in their professional development. To identify how the Women in Engineering Program could facilitate and support the formation of this Graduate Committee, a survey was distributed to all women enrolled in engineering graduate studies at the A. James Clark School of Engineering during the spring semester of 1995. In addition, a ninety-minute focus group was conducted two weeks after the survey data were analyzed.

Results indicated strong support among women engineering graduate students for a Graduate Committee for Women Engineers. Respondents reported that they were interested in attending workshops and programs that focus on career issues and provide opportunities to receive support from female faculty and other graduate women students. In addition, gaining information about career opportunities and developing networks were identified as the most important reasons for joining the Committee. The following report provides a summary of the results and serves as a guide for initial implementation and progressive development of the Graduate Committee for Women Engineers.

There are several points along the science pipeline that female students lose interest in pursuing engineering. The transition from undergraduate to graduate education is noted as one of the most severe (Widnall, 1988). Barber (1995) explained that "despite widespread changes in the status of women in society between 1968 and 1990, there was no net gain in the percentage of qualified women (those holding bachelor's degrees) who elected to pursue advanced training in science and engineering" (p. 223). In the fall of 1994, for example, women made up 18.6% of the students enrolled in undergraduate engineering programs across the nation. However, only 16.9% of the students enrolled in a master's programs and 14.6% of the students enrolled in a doctoral programs were women (Engineering Workforce Commission, 1994).

Similar to the national engineering student enrollment trends, the percentage of women enrolled in engineering graduate degree programs at the A. James Clark School of Engineering at the University of Maryland at College Park (UMCP) remains small in comparison to that of males. In the fall of 1994, 15% of the total number of students enrolled in a graduate engineering program were women. Furthermore, only 114 (16.9%) of the 675 students enrolled in master's engineering programs and 75 (12.8%) of the 584 students enrolled in doctoral engineering programs were women.

For women, the probability of feeling isolation is greater in some engineering disciplines since the individual disciplines have dramatic differences in the percentage of women graduate engineering students enrolled. For example, at the A. James Clark School of Engineering in the fall of 1994, 16 of the 61 students enrolled in graduate programs in Chemical Engineering were women. Meanwhile, 37 of the 342 students enrolled in a graduate program in Electrical Engineering were women. Furthermore, women made up 26.6% of the total number of

students pursuing an advanced degree in Chemical Engineering and only 10.8% of the total number of students pursuing an advanced degree in Electrical Engineering. Thus, there was a lower percentage of women graduate students in Electrical Engineering in comparison to Chemical Engineering. In addition to the differences among individual engineering disciplines, in the fall of 1994, none of the disciplines had a "critical mass" of female engineering graduate students: Aerospace (17.6%), Chemical (26.2%), Civil (18.5%), Electrical (10.8%), Materials (14.3%), Fire Protection (15.2%), Mechanical (11.1%), Nuclear (23.7%). In conclusion, without a "critical mass" of female peers, women engineering students are at risk for experiencing feelings of isolation and ultimately, may be at risk for departing from the engineering pipeline (Miller, 1993).

In order to mitigate the potential isolation experienced by women in graduate engineering education, the Women in Engineering Program at UMCP used funding from the Alfred P. Sloan Foundation to establish a Graduate Committee for Women Engineers. As delineated in the grant proposal, the purpose of the Graduate Committee for Women Engineers was to build a cohesive group of women graduate students to mentor and assist each other in their professional development.

To identify how the Women in Engineering Program could effectively facilitate the formation of a Graduate Committee, a survey was distributed to all women enrolled in engineering graduate studies at the A. James Clark School of Engineering during the spring semester of 1995. The survey assessed students' attitudes about their experience at the School of Engineering as well as their ideas about the development of a Graduate Committee for Women Engineers. In addition, a ninety-minute focus group was conducted two weeks after the survey data were collected. This qualitative method supplemented the survey by allowing students to

provide more elaborate responses. The following report provides an overall summary of the survey and focus group results and will serve as a guide throughout the initial implementation and progressive development of the Graduate Committee for Women Engineers.

The Survey: Graduate Women in Engineering

The 28-item survey was designed specifically to assess the female engineering students' attitudes about their experience at the School of Engineering as well as their ideas for the development of a Graduate Committee for Women Engineers. The four-part survey assessed demographic information, opinions about being a female graduate student in the School of Engineering, and ideas about the development of the Graduate Committee for Women Engineers. Finally, the survey assessed respondents' perceptions about the most important issues for women engineers during graduate school.

The first section of the survey included 11 demographic questions (e.g., race/ethnicity, engineering department, family constellation). The second section elicited respondents' opinions about being a graduate student in the School of Engineering, including nine questions on the educational climate of the School of Engineering. An example of a typical question assessing the climate was: "All faculty members treat me with fairness and respect." All of the questions were based on a five-point Likert scale ranging from strongly disagree to strongly agree (i.e., 1 = strongly disagree and 5 = strongly agree). In addition, two questions assessed the respondents' level of interest in joining and taking a leadership role in the Graduate Committee for Women Engineers. The third part of the survey focused specifically on the respondents' ideas for the Graduate Committee for Women Engineers and included six questions. For example, respondents were asked to indicate all the reasons they were interested in joining the Graduate Committee and then to indicate the most important reason for their interest. Finally, the fourth

section included an open-ended question about the most important issues for the Women in Engineering Program to address. The final question invited the respondents to include any further comments or suggestions.

The survey was developed by the Program Evaluator of the Women In Engineering Program at UMCP. All of the questions were developed specifically to assess the women in the School of Engineering at UMCP; however, the nine questions focusing on climate issues in engineering were adapted, with permission, from on a survey originally developed and administered in 1992 to assess the climate of the College of Engineering at the University of California at Davis (Henes & Bland, 1992).

In February 1995, a total of 180 surveys were distributed by mail to all of the female engineering students enrolled in graduate studies at the School of Engineering. A cover letter explaining the purpose of the study was included. Seventy-six of the surveys were returned which resulted in a 42% return rate.

Who are Graduate Women in Engineering?

In identifying the racial and ethnic demographics of the respondents, the majority (39%) were Asian/Asian-American/Pacific Islander. Thirty-four percent identified themselves as White/Caucasian of European Descent, 9% as African-American/Black, 5% as White/Caucasian of Middle Eastern Descent, 3% as Hispanic/Latina, 3% as Biracial/Multiracial, and 5% as other. In addition, nearly half (45%) of the women were between the ages of 26 and 29. Finally, when asked to describe their family constellation, slightly more than half of the women reported being married (51%). Forty-two percent of the respondents were single, and 7% were living with a partner. In addition, the majority of respondents reported that they did not have any children (79%) while 21% reported that they had one or more children.

In assessing the respondents' undergraduate education, the overwhelming majority attended a four-year institution (91%). Seven percent reported that they had transferred to a four-year institution from a two-year institution to complete their bachelor of science degree. The remaining 3% defined their educational experience as "other." Regarding their current educational program, 29% were completing a graduate degree in Civil/Environmental engineering. Other students reported studying the following engineering disciplines: Chemical (21%), Aerospace (18%), Materials and Nuclear (9%), Mechanical (9%), Fire Protection (8%), Electrical (3%), and other (3%). Fifty-nine percent of the women reported that they were enrolled in a master's degree program, while 39% reported that they were enrolled in a doctoral program.

Opinions About Being a Female Graduate Student in Engineering

Regarding the climate and culture of engineering, participants were asked about their experiences with faculty inside and outside of the classroom. Specifically, participants were asked whether they experienced support from faculty, were respected and treated fairly, received adequate advising, and felt encouraged to approach faculty outside the classroom. Participants were also asked to assess their experiences with peers in the classroom, including group work during labs.

Based on a five-point Likert scale (1 = Strongly Disagree and 5 = Strongly Agree), the majority (69%) of participants agreed or strongly agreed that faculty members were supportive, 21% were neutral, and 10% disagreed (mean = 2.76; standard deviation = .92). When asked whether faculty members treated students with fairness and respect, 59% reported that they agreed or strongly agreed, 28% were neutral, and 13% disagreed (mean = 2.59, standard deviation = 1.00). In a similar pattern, 59% of the participants agreed or strongly agreed that the

advising they received from faculty was adequate, 24% were neutral, and 17% disagreed (mean = 2.54; standard deviation = .95). Finally, 63% agreed or strongly agreed that they felt comfortable approaching professors for help outside the classroom (i.e., advising, course work, careers, research ideas) while 22% of the respondents disagreed or strongly disagreed with this statement (mean = 3.58; standard deviation = 1.19).

Students were asked to assess their experiences in the classroom and in labs with peers. Seventy-three percent agreed or strongly agreed that they felt that they were regarded as equal participants with male students in group work (i.e., lab work and group projects), 16% were neutral, and 17% disagreed (mean = 2.98; standard deviation = .95). Similarly, 62% agreed or strongly agreed that they were comfortable asking questions among peers in the classroom, 21% were neutral, and 17% disagreed (mean = 2.69; standard deviation = 1.13). Furthermore, 64% of the respondents disagreed or strongly disagreed that they have felt discouraged about pursuing an engineering degree, 16% were neutral, and 20% agreed or strongly agreed (mean = 1.33; standard deviation = 1.14). In addition, 83% of all the participants agreed or strongly agreed that they thought they would be an excellent engineer, 14% were neutral, and 1% disagreed (mean = 3.18; standard deviation = .73).

Finally, respondents wrote comments about the most important issues for women engineers during graduate school as well as the role the Women in Engineering Program could play in improving women's educational experiences. The following list provides a summary of the most salient issues: career development (i.e., identifying fellowships and job placement opportunities), sexual discrimination, recruitment and support for minority women, assertiveness skills, communication between faculty and students, family and child care, support to reduce

feelings of isolation, and an opportunity to exchange ideas and experiences with other graduate women in engineering.

Ideas About the Development of the Graduate Committee for Women Engineers.

The majority of respondents were interested in and supported the establishment of a Graduate Committee for Women Engineers. Forty-five participants agreed or strongly agreed that they were interested in becoming a member of the Committee for Women Engineers (58%), 30% were neutral, and 10% disagreed (mean = 2.70; standard deviation = .98). Fourteen women (18%) indicated that they would be interested in taking on a leadership role in the Committee. In a similar pattern, more than half of the respondents (54%) had already heard about the student organization WAGSEM (Women Are Great In Science, Engineering, and Math) which was established in the School of Computer, Math, and Physical Sciences at UMCP in 1994. Thirteen respondents reported that they had attended one of the WAGSEM meetings.

Participants were asked to identify the reasons why they would be interested in joining the Graduate Committee for Women Engineers as well as the types of workshops and programs they would be interested in attending. The graduate women reported that they wanted the Committee to provide opportunities to enhance their career, to receive support, and to participate in social events. When asked to indicate "all the reasons you are interested in joining the Committee," participants reported the following: information about career opportunities (71%), networking (64%), support (51%), social (45%), information about scholarships, fellowships, and assistantships (45%), building relationships with faculty (36%), mentoring opportunities (31%), information about engineering degrees (27%), and information on community service (24%). Furthermore, participants were most interested in the following three topics for programs and workshops: how to succeed in working in industry (70%), career development (68%), and

how to succeed in working in academia (47%). Other interests included time management (41%), scholarship/fellowship information (37%), stress management (37%), balancing work and family responsibilities (36%), sexual harassment issues (15%), and brown bag lunches with faculty (17%).

The Focus Group: A Closer Look

In order to identify participants for the focus group, a postcard was sent with the written survey explaining the purpose of the focus group and requesting their participation. Eleven women returned the postcard and were contacted by phone. Of the 11, 6 female engineering graduate students took part in the ninety-minute focus group. Within the allotted ninety minutes, the following topics were discussed: the purpose of a graduate organization for women in engineering, the types of programs and workshops that would provide assistance, and the collaborative relationship between the Women in Engineering Program and the Graduate Committee for Women Engineers.

Participants began the focus group by discussing how the Graduate Committee for Women Engineers could be organized and the role it could play in the lives of graduate women. Similar to the responses on the written survey, many suggested that programs and workshops could provide opportunities to establish professional networks with practicing engineers, to build mentoring relationships with female faculty and other female graduate students, and to enhance their career development. In addition, throughout the focus group, students emphasized that summer would be an excellent time to offer programs. They explained that most graduate students were still in the area to complete their research and often had more flexible schedules than during the fall and spring semesters.

Support and networking. The committee could play a pivotal role in providing opportunities for students to gain support from one another and from faculty. First, it was suggested that the graduate organization inform the undergraduate Society for Women Engineers of its development and progress which would enable the two societies to establish a collaborative working relationship. Secondly, the participants emphasized the importance of having a Graduate Women's study room. Presently, graduate students without a graduate assistantship office do not have access to a room on campus where they can meet other engineering graduate students outside of class. In addition, all the female graduate students commute to campus and as a result have time between classes available for studying. Thus, a Graduate Women's study room could serve as a central area for female graduate students to study between classes as well as to meet other women students. Similar to many of the undergraduate committee lounges, this could also be an area where students could store their food, establish a homework file cabinet, interact with peers, and ultimately, develop a sense of belonging.

Through the focus group discussion, two groups of students were identified as needing special attention: incoming first-year masters and doctoral students and international students. In order to provide a built-in network and support system for incoming students, a "buddy system" was suggested. Through this program, women students who had completed their first year of graduate school would pair up with incoming women students. This initial connection would provide the new students an opportunity to ask questions and become familiar with the transitions related to the experience of graduate school. A picnic for all women graduate students at the beginning of September could be organized to welcome the new students and provide an opportunity for them to meet their "buddy." In addition, as indicated by several

members of the focus group, international students are challenged with the unique experience of adjusting to a new school and living in a new country. In order to ensure that international students feel welcome to use the services and programs provided, it is important to make a special effort to contact them through electronic mail, flyers, and posters.

Participants discussed the need to connect with faculty outside the classroom and to establish mentoring relationships. In the past, informal brown bag lunches with the women faculty, graduate students, staff, and administration have been successful providing such a forum. Several participants suggested that this tradition continue. This general topic also generated an in-depth discussion of how difficult it can be to know which faculty members are interested in supporting students through mentoring. There was an enthusiastic response to the suggestion of creating a list of faculty who want to be mentors to graduate students. This list would help students identify faculty with similar interests and facilitate the process of fostering relationships with professors.

Career development programs and workshops. The women students expressed an interest in a workshop locating jobs through the Internet. Participants reported that it would be important that the instructions be simple and clear since many students were unfamiliar with how to access the Internet. Participants also indicated that they would like an opportunity to have a workshop that would allow students to work individually with instructors in a twenty-minute session. Finally, it was suggested that the workshop be held in the AT&T Teaching Theater on the UMCP campus so that a large group of people could have hands-on experience during the workshop. In addition, students suggested that the newly formalized graduate organization contact Society of Women Engineers professionals who presently work in industry and are willing to come to talk

with them about their own career development. A panel of women engineers to discuss working in both industry and academia was also a point of interest.

Finally, participants reported that the UMCP's Career Development Center focused specifically on the career development and job placement of undergraduates, often overlooking the unique experiences of graduate students. Thus, the Graduate Committee for Women Engineers could work in collaboration with the Career Development Center to define the needs of engineering graduate students and to identify programs (job searching, interviewing skills, and internship opportunities) to enhance their career development.

Organization of the Graduate Committee for Women Engineers

In order to organize the Graduate Committee in a fashion that was practical for the time-limited schedules of graduate students as well as productive, participants suggested that a Task Force within the Committee be established to organize meetings and prioritize issues addressed. Within this Task Force, there would be a core group of leaders who would be the central mediators and representatives of the Committee. Finally, the office of the Women in Engineering Program would work with this core group to help organize mailings, publicize events, and provide other assistance.

Conclusion

Based on the results of the survey and focus group, it was apparent that there was a keen interest among female graduate students in establishing a Graduate Committee for Women Engineers. In addition, the graduate women reported that the Committee could be a powerful force in establishing professional networks with practicing engineers, building mentoring relationships with female faculty and other female graduate students, and enhancing their career

development. Finally, in terms of the implementation of programs and workshops, the Women in Engineering Program could work collaboratively with a core group of leaders of the Committee to help organize mailings and publicize events.

In conclusion, the Graduate Committee for Women Engineers will serve as an intervention to recruit and retain a greater number of women students in graduate engineering programs. Establishing a community among female graduate students would mitigate the isolation that can occur due to the small number of women in each engineering discipline. Furthermore, the programs offered by the Committee would foster a greater sense of belonging among graduate women and thereby reduce the number of women who depart from the engineering pipeline.

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